Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended): A method for nanomachining a precise structure by particle-track-guided-etching comprising:

irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer;

depositing a layer of resist material over said irradiated surface of said wafer;

selectively removing portions of said layer of resist material to generate an etching pattern on irradiated surface of said wafer; and

etching said wafer according to said etching pattern;

wherein said etching is guided by said particle tracks.

2. (original): A method as recited in claim 1, wherein said charged particle beam is directed to said surface of said wafer with a predetermined collimation at a desired direction.

3. (original): A method as recited in claim 1, wherein said etched wafer comprises a final nanomachined structure.

4. (original): A method as recited in claim 1, wherein said etched wafer comprises a negative of a final nanomachined structure.

5. (original): A method as recited in claim 4, wherein said final nanomachined structure is formed by electroforming using said negative.

6. (original): A method as recited in claim 5, wherein said electroforming comprises electroplating.

7. (original): A method as recited in claim 1, wherein said wafer comprises a semiconductor material.

8. (original): A method as recited in claim 1, wherein said wafer comprises an insulator material.

9. (original): A method as recited in claim 1, wherein said charged particle beam is produced by removing some or all electrons from neutral atoms by an accelerator or comprises alpha particles emitted from a radioactive source.

10. (original): A method as recited in claim 1, wherein said irradiating of said wafer comprises placing said wafer in said particle beam in a desired direction with respect to the wafer surface.

11. (original): A method as recited in claim 10, wherein said desired direction is perpendicular to the wafer surface.

12. (original): A method as recited in claim 10, wherein said desired direction has an angle of less than ninety degrees with respect to the plane of the wafer surface.

13. (original): A method as recited in claim 1, wherein said particle tracks are substantially parallel to each other.

14. (original): A method as recited in claim 1, wherein said particle tracks are oriented to intercept at a substantially small point if extended.

15. (original): A method as recited in claim 1, wherein said step of depositing a layer of resist material over said irradiated surface of said wafer comprises deposition of a single or multilevel resist layers using spinning or vacuum coating.

16. (original): A method as recited in claim 1, wherein said layer of resist material is suitable for producing said etching pattern and is stable during said etching step.

17. (original): A method as recited in claim 1, wherein said step of selectively removing portions of said layer of resist material to generate an etching pattern on irradiated surface of said wafer comprises writing a pattern on said layer of resist material using an electron beam writing machine and subsequent processing to produce the desired pattern.

18. (original): A method as recited in claim 1, wherein said layer of resist material comprises a single layer of organic resist material.

19. (original): A method as recited in claim 1, wherein said layer of resist material comprises electron beam resist.

20. (original): A method as recited in claim 1, wherein said layer of resist material comprises a multilevel resist structure established for improving the aspect ratio of electron beam lithography.

21. (original): A method as recited in claim 17, wherein said subsequent processing comprises dissolution of selective portions of said layer of resist material using a solvent.

22. (original): A method as recited in claim 17:

wherein said layer of resist material comprises sublayers of dissimilar materials; and

wherein said subsequent processing comprises dissolution of selective portions of said layer of resist material using a solvent and plasma based etching.

23. (currently amended): A method as recited in claim 1:

wherein said etching of said wafer comprises immersing said wafer in an etching solution;

wherein said etching pattern is partially or completely transferred to the wafer;

wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern.

~~and the aspect ratio of the etched portion of said wafer to that of said etched pattern is substantially greater than one.~~

24. (original): A method as recited in claim 23, wherein said etched wafer comprises a final nanomachined structure.

25. (original): A method as recited in claim 23, wherein said etched wafer comprises a negative of a final nanomachined structure.

26. (original): A method as recited in claim 25, wherein said final nanomachined structure is formed by electroforming using said negative.

27. (original): A method as recited in claim 26, wherein said electroforming comprises electroplating.

28. (currently amended): A particle-track-guided etching method for nanomachining a precise structure with a high aspect ratio, comprising:

irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer with a desired depth and alignment;

depositing a layer of pattern forming resist material on the wafer surface irradiated by said particle beam;

generating a precise pattern on the pattern forming layer; ~~and~~

etching the areas of said wafer that are not covered by the precise pattern;

wherein said etching is guided by said particle tracks.

29. (currently amended): A method as recited in claim 28[[,]]:

wherein said charged particle beam is directed to said surface of said wafer with a predetermined collimation at a desired direction; and

wherein the level of said suitable energy exceeds 0.5 MeV.

30. (original): A method as recited in claim 28, wherein said etched wafer comprises a final nanomachined structure.

31. (original): A method as recited in claim 28, wherein said etched wafer comprises a negative of a final nanomachined structure.

32. (original): A method as recited in claim 31, wherein said final nanomachined structure is formed by electroforming using said negative.

33. (original): A method as recited in claim 32, wherein said electroforming comprises electroplating.

34. (original): A method as recited in claim 28, wherein said wafer comprises a semiconductor material.

35. (original): A method as recited in claim 28, wherein said wafer comprises an insulator material.

36. (original): A method as recited in claim 28, wherein said charged particle beam is produced by removing some or all electrons from neutral atoms by an accelerator or consists of alpha particles emitted from a radioactive source.

37. (original): A method as recited in claim 28, wherein said irradiating of said wafer comprises placing said wafer in said particle beam in a desired direction with respect to the wafer surface.

38. (original): A method as recited in claim 37, wherein said desired direction is perpendicular to the wafer surface.

39. (original): A method as recited in claim 37, wherein said desired direction has an angle of less than ninety degrees with respect to the plane of the wafer surface.

40. (original): A method as recited in claim 28, wherein said particle tracks are substantially parallel to each other.

41. (original): A method as recited in claim 28, wherein said particle tracks are oriented to intercept at a substantially small point if extended.

42. (original): A method as recited in claim 28, wherein said step of depositing a layer of resist material over said irradiated surface of said wafer comprises deposition of a single or multilevel resist layers using spinning or vacuum coating.

43. (original): A method as recited in claim 28, wherein said layer of resist material is suitable for producing said etching pattern and is stable during said etching step.

44. (original): A method as recited in claim 28, wherein said step of selectively removing portions of said layer of resist material to generate an etching pattern on irradiated surface of said wafer comprises writing a pattern on said layer of resist material using an electron beam writing machine and subsequent processing to produce the desired pattern.

45. (original): A method as recited in claim 28, wherein said layer of resist material comprises a single layer of organic resist material.

46. (original): A method as recited in claim 28, wherein said layer of resist material comprises electron beam resist.

47. (original): A method as recited in claim 28, wherein said layer of resist material comprises a multilevel resist structure established for improving the aspect ratio of electron beam lithography.

48. (original): A method as recited in claim 44, wherein said subsequent processing comprises dissolution of selective portions of said layer of resist material using a solvent.

49. (original): A method as recited in claim 44:

wherein said layer of resist material comprises sublayers of dissimilar materials; and

wherein said subsequent processing comprises dissolution of selective portions of said layer of resist material using a solvent and plasma based etching.

50. (currently amended): A method as recited in claim 28:

wherein said etching of said wafer comprises immersing said wafer in an etching solution;

wherein said etching pattern is partially or completely transferred to the wafer;

wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern.

~~and the aspect ratio of the etched portion of said wafer to that of said etched pattern is substantially greater than one.~~

51. (original): A method as recited in claim 50, wherein said etched wafer comprises a final nanomachined structure.

52. (original): A method as recited in claim 50, wherein said etched wafer comprises a negative of a final nanomachined structure.

53. (original): A method as recited in claim 52, wherein said final nanomachined structure is formed by electroforming using said negative.

54. (original): A method as recited in claim 53, wherein said electroforming comprises electroplating.

55. (currently amended): A particle-track-guided-etching method for nanomachining a precise structure with a high aspect ratio, comprising:

irradiating a wafer with a charged particle beam of suitable energy and predetermined collimation at a desired direction with respect to said wafer surface to form particle tracks capable of discrete etching guided by said particle tracks in said wafer with a desired depth and alignment;

depositing a layer of pattern forming resist material on the wafer surface irradiated by the particle beam;

generating a precise pattern on the pattern forming layer; and

etching the areas of wafer that are not covered by the precise pattern;

wherein said etching is guided by said particle tracks.

56. (original): A method as recited in claim 55, wherein said etched wafer comprises a final nanomachined structure.

57. (original): A method as recited in claim 55, wherein said etched wafer comprises a negative of a final nanomachined structure.

58. (original): A method as recited in claim 57, wherein said final nanomachined structure is formed by electroforming using said negative.

59. (original): A method as recited in claim 58, wherein said electroforming comprises electroplating.

60. (original): A method as recited in claim 55, wherein said wafer comprises a semiconductor material.

61. (original): A method as recited in claim 55, wherein said wafer comprises an insulator material.

62. (original): A method as recited in claim 55, wherein said charged particle beam is produced by removing some or all electrons from neutral atoms by an accelerator or consists of alpha particles emitted from a radioactive source.

63. (currently amended): A method as recited in claim 55[[,]]<u>:</u>

wherein said irradiating of said wafer comprises placing said wafer in said particle beam in a desired direction with respect to the wafer surface<u>; and</u>

<u>wherein the level of said suitable energy exceeds 0.5 MeV</u>.

64. (original): A method as recited in claim 63, wherein said desired direction is perpendicular to the wafer surface.

65. (original): A method as recited in claim 63, wherein said desired direction has an angle of less than ninety degrees with respect to the plane of the wafer surface.

66. (original): A method as recited in claim 55, wherein said particle tracks are substantially parallel to each other.

67. (original): A method as recited in claim 55, wherein said particle tracks are oriented to intercept at a substantially small point if extended.

68. (original): A method as recited in claim 55, wherein said step of depositing a layer of resist material over said irradiated surface of said wafer comprises deposition of a single or multilevel resist layers using spinning or vacuum coating.

69. (original): A method as recited in claim 55, wherein said layer of resist material is suitable for producing said etching pattern and is stable during said etching step.

70. (original): A method as recited in claim 55, wherein said step of selectively removing portions of said layer of resist material to generate an etching pattern on irradiated surface of said wafer comprises writing a pattern on said layer of resist material using an electron beam writing machine and subsequent processing to produce the desired pattern.

71. (original): A method as recited in claim 55, wherein said layer of resist material comprises a single layer of organic resist material.

72. (original): A method as recited in claim 55, wherein said layer of resist material comprises electron beam resist.

73. (original): A method as recited in claim 55, wherein said layer of resist material comprises a multilevel resist structure established for improving the aspect ratio of electron beam lithography.

74. (original): A method as recited in claim 70, wherein said subsequent processing comprises dissolution of selective portions of said layer of resist material using a solvent.

75. (original): A method as recited in claim 70:

wherein said layer of resist material comprises sublayers of dissimilar materials; and

wherein said subsequent processing comprises dissolution of selective portions of said layer of resist material using a solvent and plasma based etching.

76. (currently amended): A method as recited in claim 55:

wherein said etching of said wafer comprises immersing said wafer in an etching solution;

wherein said etching pattern is partially or completely transferred to the wafer;

wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern.

~~and the aspect ratio of the etched portion of said wafer to that of said etched pattern is substantially greater than one.~~

77. (original): A method as recited in claim 76, wherein said etched wafer comprises a final nanomachined structure.

78. (original): A method as recited in claim 76, wherein said etched wafer comprises a negative of a final nanomachined structure.

79. (original): A method as recited in claim 78, wherein said final nanomachined structure is formed by electroforming using said negative.

80. (original): A method as recited in claim 79, wherein said electroforming comprises electroplating.

81. (new): A method as recited in claim 1, wherein said level of said suitable energy for creating particle tracks is at least approximately 0.5 MeV.

82. (new): A method as recited in claim 1, wherein said particle tracks are generated substantially parallel to each other.

83. (new): A method as recited in claim 1, wherein said particle tracks are oriented to intercept at a substantially small point if extended.

84. (new): A method as recited in claim 1, wherein said wafer substantially comprises a material selected from the group consisting essentially of quartz crystal, silica glass and mica.

85. (new): A method as recited in claim 1, further comprising applying an etch stop material to the surface of said wafer opposite the surface deposited with said layer of resist material.

86. (new): A method as recited in claim 1:

wherein said precise structure being nanomachined comprises a zone plate structure for x-ray applications beyond one thousand electron volts;

wherein said etching pattern is a zone plate pattern having a width of at least about five nanometers;

wherein the aspect ratio of the depth of the etched particle track compared to the width of the smallest zone plate pattern is at least about ten;

wherein said zone plate structure has a diameter of at least about one millimeter.

87. (new): A method as recited in claim 1:

wherein said precise structure being nanomachined comprises a mica wafer up to approximately five microns thick;

wherein said charged particle beam is a beam of charged argon ions with a potential of at least about one hundred million electron volts per nucleon.

88. (new): A method for nanomachining a precise structure with a high aspect ratio by particle-track-guided-etching, comprising:

irradiating a first surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer with a desired depth and alignment;

depositing a layer of pattern forming resist material on said first surface of said wafer irradiated by said particle beam;

generating a precise pattern on said pattern forming layer; and

etching guided by said particle tracks under areas of said wafer that are not covered by said precise pattern;

wherein the aspect ratio of the depth of the particle track etched, compared to the width of smallest area not covered by said etching pattern, is at least about ten.

89. (new): A method as recited in claim 88, wherein said pattern forming resist material is an e-beam resist material configured to be structurally stable during etching.

90. (new): A method as recited in claim 88, wherein said pattern forming resist material comprises a multilevel resist structure established for improving the aspect ratio of the depth of the particle track etched, compared to the width of smallest area not covered by said pattern forming resist material.

91. (new): A method as recited in claim 88, wherein an etch stop material is applied to a second surface of said wafer.

92. (new): A method as recited in claim 88, wherein said pattern forming resist material is suitable for removing portions as small as five nanometers in width.

93. (new): A method as recited in claim 88, wherein said particle tracks are oriented to substantially intercept within the wafer.

94. (new): A method as recited in claim 88, wherein said wafer comprises a semiconductor material.

95. (new): A method as recited in claim 88, wherein said wafer comprises an insulator material.

96. (new): A method as recited in claim 88, wherein said wafer substantially comprises a material selected from the group consisting essentially of quartz crystal, silica glass and mica.

97. (new): A method as recited in claim 88, wherein said aspect ratio is on the order of one thousand.

98. (new): A method as recited in claim 88, wherein said suitable energy to form said particle tracks is at least about five hundred thousand electron volts.

99. (new): A method for nanomachining a zone plate structure by particle-track-guided-etching to produce a zone plate for focusing x-rays comprising:

irradiating the surface of an insulator or semiconductor wafer with a collimated charged particle beam of at least about 0.5 MeV energy and forming particle tracks capable of discrete etching guided by said particle tracks in said wafer;

depositing a layer of electron beam resist material over said irradiated surface of said wafer;

depositing a layer of etch stop over said surface of said wafer opposite said layer of etch stop;

generating a zone plate pattern on said layer of resist material by selectively removing portions of said zone plate pattern with electron beam lithography;

immersing said wafer in etching solution; and

etching, guided by said particle tracks, portions of said wafer exposed by said zone plate pattern.

100. (new): The method as recited in claim 99, wherein said zone plate has an outermost zone with a width of at most about 100 nanometers; and

wherein said zone plate has an aspect ratio greater than one;

said aspect ratio comprising the ratio of the thickness of the zone plate to the width of the outermost zone.

101. (new): The method as recited in claim 100, wherein said zone plate has an aspect ratio of at least about 16.

102. (new): The method as recited in claim 101:

wherein said zone plate has an outermost zone with a width of at most about 33 nanometers; and

wherein said zone plate has an aspect ratio of at least about 48.

103. (new): The method as recited in claim 102:

wherein said zone plate has an outermost zone with a width of at most about 10 nanometers; and

wherein said zone plate has an aspect ratio of at least about 160.

104. (new): The method as recited in claim 103:

wherein said zone plate has an outermost zone with a width of at most about 10 nanometers and at least about 5 nanometers; and

wherein said zone plate has an aspect ratio of at least about 160 and at most about 1000.

105. (new): A zone plate structure, comprising:

a zone plate;

said zone plate having a predetermined thickness;

said zone plate having an outermost zone with a width of less than about 100 nanometers;

wherein said zone plate is fabricated by particle-track-guided-etching.

106. (new): A zone plate structure as recited in claim 105:

wherein said zone plate has an aspect ratio greater than about 10; and

wherein said aspect ratio comprises the ratio of the thickness of the zone plate to the width of the outermost zone.

107. (new): A zone plate structure as recited in claim 106, wherein said zone plate has an aspect ratio greater than about 16.

108. (new): A zone plate structure as recited in claim 107:

wherein said zone plate has an outermost zone with a width not exceeding about 33 nanometers; and

wherein said zone plate has an aspect ratio greater than about 48;

109. (new): A zone plate structure as recited in claim 108:

wherein said zone plate has an outermost zone with a width not exceeding about 10 nanometers and at least about 5 nanometers; and

wherein said zone plate has an aspect ratio of at least about 160 and not exceeding about 1000.

110. (new): A zone plate structure as recited in claim 105, wherein said zone plate has a diameter up to about 3 millimeters.

111. (new): A zone plate structure as recited in claim 105, wherein said zone plate is adapted to focus x-rays having an energy level of up to about 70 keV.

112. (new): A zone plate structure as recited in claim 105, wherein said zone plate is further adapted to focus x-rays having an energy level of at least about 8 keV.

113. (new): A zone plate structure as recited in claim 105, wherein said zone plate comprises a gold material.

114. (new): A zone plate structure, comprising:

a zone plate;

said zone plate having a diameter of up to about 3 millimeters;

said zone plate having a predetermined thickness;

said zone plate having an outermost zone with a width of less than about 100 nanometers:

said zone plate having an aspect ratio greater than about 10;

said aspect ratio comprising the ratio of the thickness of the zone plate to the width of the outermost zone;

wherein said zone plate is adapted to focus x-rays having an energy level up to about 70 keV;

wherein said zone plate comprises a gold material; and

wherein said zone plate is fabricated by particle-track-guided-etching.

115. (new): In a zone plate, the improvement comprising:

said zone plate having a predetermined thickness;

said zone plate having an outermost zone with a width of less than about 100 nanometers.

116. (new): An improved zone plate as recited in claim 115:

wherein said zone plate has an aspect ratio greater than about 10; and

wherein said aspect ratio comprises the ratio of the thickness of the zone plate to the width of the outermost zone.

117. (new): An improved zone plate as recited in claim 116, wherein said zone plate has an aspect ratio greater than about 16.

118. (new): An improved zone plate as recited in claim 117:

wherein said zone plate has an outermost zone with a width not exceeding about 33 nanometers; and

wherein said zone plate has an aspect ratio greater than about 48.

119. (new): An improved zone plate as recited in claim 118:

wherein said zone plate has an outermost zone with a width not exceeding about 10 nanometers and at least about 5 nanometers; and

wherein said zone plate has an aspect ratio of at least about 160 and not exceeding about 1000.

120. (new): An improved zone plate as recited in claim 115, wherein said zone plate has a diameter up to about 3 millimeters.

121. (new): An improved zone plate as recited in claim 115, wherein said zone plate is adapted to focus x-rays having an energy level of up to about 70 keV.

122. (new): An improved zone plate as recited in claim 121, wherein said zone plate is further adapted to focus x-rays having an energy level of at least about 8 keV.

123. (new): An improved zone plate as recited in claim 115, wherein said zone plate comprises a gold material.